Annals of Clinical and Analytical Medicine
Original Research

Ultrasound-guided erector spinae plane block versus rhomboid intercostal block for postoperative analgesia following thoracotomy

Erector spinae versus rhomboid block for thoracotomy

Tahsin Şimek[1], Fatih Doğu Geyik[1], Aynur Kaynar Şimşek[2], Yücel Yüce[1], Kemal Tolga Saraçoğlu[1], Recep Demirhan[3]
[1] Department of Anesthesiology and Reanimation, Health Sciences University, Kartal Dr. Lutfi Kirdar Training and Research Hospital
[2] Department of Nursing, Faculty of Health Sciences, Marmara University
[3] Department of Thoracic Surgery, Health Sciences University, Kartal Dr. Lutfi Kirdar Training and Research Hospital, Istanbul, Turkey

Abstract
Aim: For the thoracotomy pain relief, opioids, thoracic paravertebral and epidural interventions are frequently used practices. In recent years, interfascial blocks such as the erector spinae plan block (ESPB) and rhomboid intercostal block (RIB) have started to be used for analgesia. We aimed to compare the postoperative analgesic effect of ESPB, RIB, and a control (C) group in pain management after open thoracotomy.
Material and Methods: This is a single-centered randomized controlled trial. A total of 75 patients were included in the study in three groups as the ESPB, RIB and control (C) groups. Under general anesthesia, in block groups, blockage was performed with 20 ml 0.25% bupivacaine. In Group C, no procedures other than the standard postoperative analgesia protocol were performed. The amount of postoperative analgesic consumption by the patients, and visual analogue scale (VAS) values were recorded.
Results: In group ESPB and RIB, the mean 24-hour tramadol consumption was 124±29.08 mg and 116±28.65 mg, respectively ($p>0.05$). In Group C, the consumption was 204±44.06 mg, significantly higher than in group ESPB and group RIB ($p=0.004$). The VAS values ($p<0.05$) and the numbers of patients needing rescue analgesic ($p=0.048$) were lower in groups ESPB and RIB than in group C. There was no significant difference between group ESPB and group RIB in any of these parameters
Discussion: ESPB and RIB were similar and they are more effective than the control group, whereas the former did not have superiority over each other.

Keywords
Analgesia, Block, Thoracotomy

DOI: 10.4328/ACAM.21189 Received: 2022-04-14 Accepted: 2022-06-11 Published Online: 2022-06-21 Printed: 2022-08-01 Ann Clin Anal Med 2022;13(8):932-936
Corresponding Author: Tahsin Şimşek, Health Sciences University, Kartal Dr. Lütfi Kirdar Training and Research Hospital, Cevizli Mh., Semsi Denizer Cd., E-5 Karayolu Cevizli Mevkii, 34890, Kartal, Istanbul, Turkey.
E-mail: simsektahsin2017@gmail.com P: +90 216 441 39 00
Corresponding Author ORCID ID: https://orcid.org/0000-0002-3068-4998

Introduction

Thoracotomy is one of the most painful surgical procedures. Providing effective analgesia is highly important especially for preventing respiratory and thromboembolic complications [1]. Multimodal analgesia is frequently used to treat pain after thoracotomy and includes neuraxial, paravertebral, and fascial plane blocks, as well as opioids, acetaminophen, and other medications like NSAIDS [2]. However, neuraxial approaches such as thoracic epidural analgesia may lead to side effects such as hypotension, dural puncture, and motor block [3,4]. Opioids may display several negative effects such as nausea-vomiting, constipation, respiratory depression, and itching [4].

In recent years, interfascial plane blocks such as the erector spinae plane block (ESPB) [2,5] and rhomboid intercostal block (RIB) [6,7] have started to be used. ESPB is a regional block method developed by Forero [8]. With this method, by injecting a local anesthetic between the transverse process and erector spinae muscles, the blockage of the dorsal and ventral branches of the regional spinal nerves is provided, and analgesia is induced. It has a broad usage area in surgeries in the thoracal and abdominal regions such as thoracotomy, hysterectomy, and lumbar surgery [9]. In addition to being an effective analgesic technique, its low complication risk, and high feasibility are among its main advantages [10]. In RIB, by making a local anesthetic agent injection between the intercostal muscles and the rhomboid muscle, with the blockage of the intercostal and thoracal spinal nerves, analgesia is provided in the anterior and posterior hemithorax [11]. It was reported that this method provided an effective and safe analgesic [12]. It has been used in thoracic surgery [6,7], breast surgery [13], rib fractures [11], and myofascial pain [14]. Determining the most effective and feasible method in post-thoracotomy pain management is crucially important to increase patient comfort, reduce analgesic consumption and avoid complications. The literature review revealed studies on the effectiveness of RIB and ESPB in thoracotomy analgesia. However, most of these studies have consisted of case series, and the number of randomized controlled studies is very low. Moreover, a study comparing RIB and ESPB was not encountered.

This study aimed to compare the effects of ESPB, RIB, and a control group in terms of pain management after open thoracotomy. The primary out¬come was to compare the postopera¬tive 24-h consumption of tramadol as a rescue analgesia. The secondary out¬come was to compare VAS, number of patients requiring rescue analgesics, nausea, and vomiting.

Material and Methods

This prospective randomized controlled trial was conducted between 1 February 2020 and 1 January 2021 at a Research and Training Hospital. The protocol of the study was approved by the Local Ethics Committee (protocol no: 2019/514/150/21-date: 27.03.2019) and registered on the ClinicalTrials.gov (NCT04294394). All patients provided written informed consent for their inclusion in this study. The Consolidated Standards of Reporting Trials (CONSORT) flow diagram was used for patient enrollment and allocation (Figure 1).

Patients aged between 18 and 75 years with the American Society of Anesthesiologists (ASA) physical statuses I-III, who were scheduled for the elective resection of non-metastatic lung malignancies, were included in the study. Patients who did not agree to participate, as well as those who had coagulopathy, liver and kidney dysfunctions, or local anesthetic allergies, were excluded.

All patients were monitored in the operating room with temperature monitoring, electrocardiogram (ECG), pulse oximetry (SpO2), and non-invasive blood pressure measurement. For general anesthesia, the patients were given 1-1.5 mcg/kg fentanyl, 1-2 mg/kg propofol and 0.6 mg/kg rocuronium bromide in IV induction. Following tracheal intubation, for the maintenance of anesthesia, sevoflurane 1-2% in a mixture of oxygen and air and remifentanil at the dose of 0.1-0.3 mcg/kg/min were administered. After ending of surgical procedure and before reversing the muscle relaxant, patients were randomly divided using a computer-generated table into 3 equal groups as the control group (Group C), erector spinae plane block group (Group ESPB), and rhomboid intercostal block group (Group RIB). The blocks were applied by the same anesthesiologist who was not involved in the data collection or analysis process. ESPB or RIB was applied under general anesthesia on the patients except for those in the control group.

Thirty minutes before the end of the surgery, all patients including the control group were given 100 mg of tramadol and 1 g of paracetamol. For nausea-vomiting, 10 mg metoclopramide was administered. Following the end of the operation, after administering 2-4 mg/kg sugammadex for decurarization and observing sufficient respiratory effort, the patient was extubated and transferred to the post-anesthetic care unit.

Block Application

Erector spinae plane block

The patient was placed in a lateral position. Regional sterile conditions were achieved by 10% povidone-iodine solution. An experienced anesthesia doctor placed a 6-13 MHz linear ultrasonography (USG) probe (Esaote, Via E. Melen, 77 16152 Genova, Italy) at 3 cm lateral of the T5 spinous process. The trapezius, rhomboid major, and erector spinae muscles were imaged. With a 20 G and 100 mm block needle (Stimuplex® Ultra 360® B-Braun medical, Melsungen, Germany), the fascial plane between the transverse process and erector spinae muscle was entered. After conducting hydro dissection with 3 ml normal saline (NS) for confirmation, 20 ml of the local anesthetic solution consisting of 0.25% bupivacaine was given.

Rhomboid intercostal block

The patient was placed in a lateral position. Regional sterile conditions were achieved by 10% povidone-iodine solution. A 6-13 MHz linear USG probe was placed at the medial of the scapula on the level of the thoracal 6th-7th vertebrae in the sagittal position. The trapezius, rhomboid major, intercostal muscles, and costae were imaged. With a 20 G and 100 mm block needle, the fascial plane between the rhomboid muscle and intercostal muscle was entered in the craniocaudal direction. After conducting hydro dissection with 3 ml NS for confirming the area, 20 ml of the local anesthetic solution consisting of 0.25% bupivacaine was given.

Standard postoperative analgesia protocol

During the 24-hour postoperative period, all patients (group

ESPB, group RIB, control group) were administered 1 g paracetamol every 8 hours. In the case that values of 4 or higher were observed in the 24-hour visual analog scale (VAS) follow-ups of the patients, tramadol was administered in the form of infusion in 30 minutes as a rescue analgesic at the dose of 1mg/kg (at a maximum of 100 mg per use)

Outcomes

The pain levels were assessed on a 10-point VAS at 1, 2, 3, 6, 9, 12, and 24 hours by pain nurses blinded to the study. Zero points were recorded as no pain, while 10 points were recorded as unbearable pain. For the first 24 hours, VAS, total tramadol consumption, number of patients, requiring rescue analgesics, and incidents of nausea and vomiting were recorded.

Sample size

A previous study [15] reported a large effect size for Tramadol consumption (d=1.424). We planned our study for three groups, and a power analysis was performed before the study for a three-group comparison and a large effect size value (f=0.4). Accordingly, when at least 66 people (at least 22 for each group) would be included in the study, this would result in 80% power within a 95% confidence interval. Considering the possibility of a loss of subjects, 15% more subjects were included in each group. We included 75 patients (25 for each group) in this study. Regarding the 'tramadol consumption quantity' results, we had a large effect size (f=0.397), and we reached 86.4% (post-analysis power) power within a 95% confidence interval.

Statistical analysis

All statistical analyses were performed using SPSS 25.0 (IBM SPSS Statistics 25 software (Armonk, NY: IBM Corp.)). Continuous variables were defined as mean ± standard deviation (for parametric tests); median (for non parametric tests) and categorical variables as numbers and percentages. The Kolmogorov-Smirnov test was used for the determination of the normal distribution. For independent groups comparisons, we used One Way Analysis of Variance (post hoc: Tukey test) when parametric test assumptions were provided, and the Kruskal-Wallis Variance Analysis (post hoc: Mann-Whitney U test with Bonferroni Correction) when parametric test assumptions were not provided. Categorical variables were analyzed using a Chi-square test. Statistical significance was determined as p<0,05.

Results

Eighty patients were screened for the study. Two patients were excluded due to having coagulopathies, and 3 patients were excluded as they did not agree to participate. The remaining 75 patients were analyzed in three groups as group ESPB, group RIB, and group C (Figure 1).

There was no significant difference among the groups in terms of the patients' distributions of age, sex, body mass index, ASA class, and operation duration. No complications developed in the patients in any group (Table 1).

There was also no significant difference between the groups in terms of their nausea-vomiting scores (Table 2).

Mean 24-hour tramadol consumption was 124 ± 29.08 mg in group ESPB, 116 ± 28.65 mg in group RIB and 204 ± 44.06 mg in group C (p = 0.004). In the post hoc analysis that was conducted, while there was no significant difference between groups the ESPB and RIB, there were significant differences

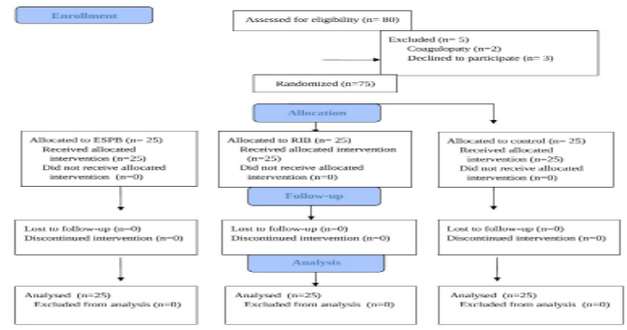

Figure 1. Flowchart of the study

Table 1. Comparison of the Demographic Characteristics of the Groups

Findings		RIB (25)	ESPB (25)	CONTROL (25)	p
		n (%)	n (%)	n (%)	
Sex	Female	9 (36)	8 (32)	9 (36)	0.062*
	Male	16 (64)	17 (68)	16 (64)	
Age (Median)	(Min-Max)	62 (35-75)	61(32-74)	58 (22-70)	0.435**
BMI (Median)	(Min-Max)	26 (25-32)	26 (22-32)	28 (22-32)	0.390**
ASA	1	7 (28)	6 (24)	7 (28)	0.635*
	2	14(56)	15 (60)	13 (52)	
	3	4 (16)	4 (16)	5 (20)	
Operation duration (Median) (Min-Max)		230 (160-450)	230 (135-300)	210 (140-380)	0.798
Complication	No	25 (100)	25 (100)	25 (100)	----
	Yes	0	0	0	

*Chi-Squared test, **Kruskal-Wallis test, RIB: Rhomboid Intercostal Block ESPB: Erector Spinae Plane Block

Table 2. Comparison of the Postoperative Findings of the Groups

Findings		RIB (25)	ESPB (25)	Control (25)	P
		n (%)	n (%)	n (%)	
Nausea-vomiting	None	22 (88)	21 (84)	18(72)	0.494*
	Mild	1 (4)	3 (12)	5(20)	
	Moderate	2 (8)	1 (4)	2(8)	
Needs rescue analgesic	No	8 (32)	9 (36)	2(8)	0.048*
	Yes	17 (68)	16 (64)	23(92)	
		Mean (±SD)	Mean (±SD)	Mean (±SD)	
Tramadol consumption quantity (mg)		116 ± 28.65	124 ± 29.08	204 ± 44.06	0.004**
		Median (Min-max)	Median (Min-Max)	Median (Min-Max)	
VAS 1 hour		2 (1-3)	2 (1-3)	3(1-7)	0.003***
VAS 3 hour		2 (1-3)	2 (0-3)	3(1-8)	<0.001***
VAS 6 hour		2 (1-5)	2 (0-6)	3(2-7)	0.027***
VAS 9 hour		2 (1-5)	2 (0-5)	3(2-7)	<0.001***
VAS 12 hour		2 (0-6)	2 (0-5)	3(2-6)	0.023***
VAS 18 hour		1 (0-6)	2 (0-2)	3(1-6)	<0.001***
VAS 24 hour		1 (0-2)	2 (0-4)	3(1-6)	<0.001***

*Fisher's exact test **One-Way Anova ***Kruskal-Wallis test, AS: Visual Analog Scale, ESPB: Erector Spiane Plane Block RIB: Rhomboid Intercostal Block

between the ESPB and C groups and between the RIB and C groups (Table 2).

There was a significant difference among the groups based on their VAS scores (VAS 1=0.003, VAS 3<0.001, VAS 6=0.027, VAS 9<0.001, VAS 12=0.023, VAS 18<0.001, VAS 24<0.001) (Table 2) and numbers of patients requiring rescue analgesic use (p=0.048) (Table 2). In the post-hoc analysis that was conducted to see the source of the difference, in terms of both the VAS scores and numbers of patients requiring analgesic use, while there was no significant difference between the ESPB and RIB groups, there were significant differences between the ESPB and C groups and between the RIB and C groups (Table 2).

Discussion

In this study, the outcomes of the non-metastatic lung malignancy patients undergoing open thoracotomy were evaluated among the ESPB, RIB, and control groups. The comparison of the ESPB and RIB groups did not result in a significant difference in terms of the postoperative 24-h tramadol consumption, VAS scores, number of patients requiring rescue analgesic. However, postoperative 24-h tramadol consumption was found to be lower in the block groups compared to the control group. The number of patients requiring rescue analgesic and the mean VAS scores was lower in the ESPB and RIB groups than in the control group.

Forero et al. [8] in their cadaver study containing case series, showed that after the dye injection in ESPB, staining was observed at the T2-T8 levels in regions containing both the ventral and dorsal rami of the spinal nerves. As a result, they concluded that ESPB created a sensory block on the posterior and anterolateral thorax. In a similar way with the help of pin-prick test we found out in our study that sensorial block occurs at the level of T3-T9 in ESPB.

A recent study found the postoperative VAS scores and analgesic consumption quantities after thoracotomy in the ESPB group were lower than those of the control group [15]. Our study also found lower VAS scores and rescue analgesic consumption quantities after ESPB compared to the control group.

Çiftçi et al. [16] observed that post-thoracotomy analgesic consumption quantities, VAS scores, and postoperative nausea-vomiting levels were lower in the ESPB group than in the control group. In our study, similar to Çiftçi et al., analgesic consumption quantities and VAS scores were also found to be lower in the ESPB group than in the control group. However, we found no significant difference between the groups in terms of their nausea-vomiting levels. The reason for this difference may be considered as the fact that Çiftçi et al. used fentanyl and meperidine as two opioid agents in their postoperative analgesia protocol.

In their cadaver study, Elsharkawy et al. [11] reported that a dye applied with RIB showed a cranial and caudal spread between the rhomboid major and intercostal muscles between the T2 and T8 levels, and there was staining in the lateral cutaneous branch of the intercostal nerves between the levels of T2 and T8 and the posterior rami of the thoracic spinal nerves on the levels of T2-T9. Additionally, they observed that in a patient with multiple costal fractures, with 25 ml 0.25% bupivacaine, there was a symptomatic improvement in the posterior, lateral, and mid-anterior hemithorax between the levels of T2 and T9. In a similar way, in our study, we saw that analgesia could be achieved by a RIB with 20 ml 0.25% bupivacaine. Studies are suggesting that the RIB practice is an effective analgesia method following breast surgery [13,17] and thoracotomy [18]. In their case series including 5 patients on RIB after thoracotomy, Ökmen K. [6] reported that the VAS scores of all patients were lower than 3, 3 patients needed low-dose rescue analgesics (50 mg tramadol in 2 patients and 75 mg tramadol in 1 patient), and 2 patients did not need rescue analgesics. In our study, there was no need for the rescue analgesic in 32% of the patients in the RIB group and 36% of the patients in the ESPB group. However, while there was a need for the rescue analgesic in 92% of the patients in the control group, there was no need only in 8%. In our study, the VAS scores were also lower than 3 in both the RIB and ESPB groups, and they were significantly lower compared to the control group.

Although thoracal epidural analgesia is accepted as the gold standard analgesic approach after thoracotomy, this technique also has some side effects. Dural puncture, epidural hematoma, spinal abscess, and significant hemodynamic sequelae resulting from local anesthesia-related sympathetic blockade are among these side effects [1,2,4].

In our study, effective analgesia levels were achieved in the patients in both groups ESPB and RIB, and no complications occurred in any patient. This is why we believe both ESPB and RIB are reliable methods. The RIB and ESPB procedures that we compared in this study did not have any analgesic superiority over each other. The reason for this was considered to be that both RIB and ESPB spread through the nerves in similar regions, and induce sensory blocks [8,11]. Despite the similar analgesic effectiveness of both interfascial blocks, between the two, we think that transverse process visualization while performing ESPB makes the procedure easier, and it may be successfully applied also by less experienced users.

Limitations

As a limitation of our study, we can conclude that the dermatomal assessment of block function may be interpreted as not formal since we performed the blocks under general anesthesia. However, we can report that, similar to routine clinical practice, we performed these blocks via ultrasonographic imaging after general anesthesia induction. Thus, this way of block application may decrease the suspicion about the effectiveness of the blocks.

The second limitation of the study may be the small sample size. New studies with larger samples may better clarify the effectiveness of these blocks.

Conclusion

In conclusion, it was observed that ESPB and RIB were techniques with low complications and high success rates. While they had no analgesic superiorities over each other after thoracotomy, as they reduced total anesthetic consumption quantities and VAS scores in comparison to the control group, it was concluded that these methods could be safely used in such operations.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some

of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement
All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

Funding: *None*

Conflict of interest
None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

References
1. Nath S, Bhoi B, Mohan VK, Talawar P. USG-guided continuous erector spinae block as a primary mode of perioperative analgesia in open posterolateral thoracotomy: a report of two cases. Saudi J Anaesth. 2018; 12(3):471-4.
2. Kelsheimer B, Williams C, Kelsheimer C. New emerging modalities to treat post-thoracotomy pain syndrome: a review. Mo Med. 2019; 116(1): 41-4.
3. Yeung JHY, Gates S, Naidu BV, Wilson MJA, Smith FG. Paravertebral block versus thoracic epidural for patients undergoing thoracotomy. Cochrane Database Syst Rev. 2016; 2(2): CD009121. DOI: 10.1002/14651858.CD009121.pub2.
4. Nagaraja PS, Ragavendran S, Singh NG, Asai O, Bhavya G, Manjunath N, et al. Comparison of continuous thoracic epidural analgesia with bilateral erector spinae plane block for perioperative pain management in cardiac surgery. Ann Card Anaesth. 2018; 21(3): 323-7.
5. Forero M, Rajarathinama M, Adhikar S, Chin KJ. Erector spinae plane (ESP) block in the management of post-thoracotomy pain syndrome. Scand. J Pain. 2017; 17: 325-9.
6. Ökmen K. Efficacy of rhomboid intercostal block for analgesia after thoracotomy. Korean J Pain. 2019; 32(2): 129-32.
7. Kumar A, Sinha C, Kumari P, Kumar A, Sinha AK, Kumar B. Ultrasound-guided rhomboid intercostal block: A pilot study to assess its analgesic efficacy in pediatric patients undergoing video-assisted thoracoscopy surgery. Indian J Anaesth. 2020; 64(11): 949-53.
8. Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ. The erector spinae plane block: a novel analgesic technique in thoracic neuropathic pain. Reg Anesth Pain Med. 2016; 41(5): 621–7.
9. De Cassai A, Bonvicini D, Correale C, Sandei L, Tulgar S, Tonetti T. Erector spinae plane block: a systematic qualitative review. Minerva Anestesiol. 2019; 85(3):308-19.
10. Kot P, Rodriguez P, Granell M, Cano B, Rovira L, Morales J, et al. The erector spinae plane block: a narrative review. Korean J Anesthesiol. 2019; 72(3):209-20.
11. Elsharkawy H, Saifullah T, Kolli S, Drake R. Rhomboid intercostal block. Anesthesia. 2016; 71(7): 856–7.
12. Tulgar S, Thomas DT, Deveci U, Özer Z. Ultrasound-guided rhomboid intercostal block provides effective analgesia for excision of elastofibroma extending to the subscapular space: The first report of use in anesthesia practice. J Clin Anesth. 2019; 52: 34-5.
13. Tulgar S, Selvi O, Thomas DT , Manukyan M, Özer Z. Rhomboid intercostal block in a modified radical mastectomy and axillary curettage patient; a new indication for novel interfascial block. J Clin Anesth. 2019; 54:158-9.
14. Piraccini E, Lorenzo ED, Maitan S. Rhomboid intercostal block for myofascial pain syndrome in a patient with amyotrophic lateral sclerosis. Minerva Anestesiol. 2019; 85(12): 1367-9.
15. Wang Q , Zhang G, Wei S, He Z, Sun L, Zheng H. Comparison of the effects of ultrasound-guided erector spinae plane block and wound infiltration on perioperative opioid consumption and postoperative pain in thoracotomy. J Coll Physicians Surg Pak. 2019; 29(12): 1138-43.
16. Çiftçi B, Ekinci M, Çelik EC, Tukac IC, Gölboyu BE, Gunluoglu MZ, et al. Ultrasound-guided erector spinae plane block and thoracic paravertebral block for postoperative analgesia management following video-assisted thoracic surgery: a prospective, randomized, controlled stud. JARSS. 2020; 28(3): 170-8.
17. Gürkan Y, Manici M, Salgın B, Dilege E, Ağcaoğlu O, Tatar S, et al. Bilateral rhomboid block may provide complete pain relief following bilateral breast surgery. J Clin Anesth. 2021; 68: 110064.
18. Altıparmak B, Toker MK, Uysal Aİ, Turan M, Demirbilek SG. The usage of single-shot ultrasound-guided rhomboid intercostal block for analgesia after thoracotomy: Clinical experience in two patients. J Clin Anesth. 2019; 56: 98-9.

How to cite this article:
Tahsin Şimek, Fatih Doğu Geyik, Aynur Kaynar Şimşek, Yücel Yüce, Kemal Tolga Saraçoğlu, Recep Demirhan. *Ultrasound-guided erector spinae plane block versus rhomboid intercostal block for postoperative analgesia following thoracotomy. Ann Clin Anal Med 2022;13(8):932-936*